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No. TB167122604

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

**TITLE: "ANTENNA CAP, ANTENNA CONNECTORS AND TELEPHONE LINE
CONNECTORS FOR COMPUTER DEVICES UTILIZING RADIO AND
MODEM CARDS"**

**CLAIM FOR BENEFIT OF EARLIER U.S.
APPLICATION UNDER 35 U.S.C. 120**

**CROSS REFERENCE TO RELATED APPLICATIONS
(CLAIMING BENEFIT UNDER 35 U.S.C. 120)**

This application is a continuation-in-part of U.S. Application Ser. No. 08/226,256 filed April 11, 1994 by Pat Kinney et al. (Attorney Docket No. DN 38000FA) which is in turn a continuation-in-part of U.S. Application Ser. No. 08/194,178 filed February 9, 1994 by Pat Kinney et al. (Attorney Docket No. DN 38000F) which is in turn a continuation-in-part of U.S. Application Ser. No. 08/154,020 filed November 17, 1993 by P. Kinney et al. (Attorney Docket No. DN 38000C) which is in turn a continuation-in-part of: U.S. Application Ser. No. 08/107,470 filed August 17, 1993 by P. Kinney and R. Mahany (Attorney Docket No. DN 38000B) which is in turn a continuation-in-part of U.S. Application Ser. No. 08/081,411 filed June 22, 1993 by P. Kinney (Attorney Docket No. DN 38000A) which is in turn a continuation-in-part of U.S. Application Ser. No. 08/053,901 filed April 27, 1993 by P. Kinney et al. (Attorney Docket No. DN 38000); and U.S. Application Ser. No. 08/097,462 filed July 26, 1993 by G. West and R. Mahany (Attorney Docket No. DN 38017).

AUTHORIZATION PURSUANT TO 37 CFR 1.71 (d) (e)

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Related Case

The present case is related to U.S. Application Ser. No. 08/114,872 filed August 31, 1993 by S. Koenck (Attorney Docket No. 36767XZAB), now U.S. Patent No. _____, which is hereby incorporated by reference.

Technical Field

The present invention relates generally to computer devices utilizing removable radio frequency communication devices used for transmitting and receiving information and more particularly to an improved apparatus for connecting an appropriate antenna to the radio frequency communication device using an antenna cap, and to an improved method and apparatus for connecting a communication card device such as a radio or modem to an appropriate antenna or telephone line.

Background Art

Many computer devices use modular components to allow increased flexibility and adaptability to various work environments. This is especially true in the area of small computing devices such as hand held computer terminals, vehicle mounted computer terminals and small lap-top computers. Along these lines, small, removable and interchangeable memory cards were developed. The memory cards have now become commonplace and the PCMCIA memory card standard has become accepted industry wide as the format to use.

The PCMCIA memory cards are relatively small having a length and width roughly the size of a credit card. The thickness of these cards is more than that of a credit card and there are several thicknesses used for different cards. These cards are designed to slide into a receiving portion of some computer device. At one end of the card is an interface section which is in essence the female portion of a connector that mates with the male end in the receiving device. All of this, including the number of pins, the layout of the pins, and the pin size for the connection, are all part of the PCMCIA standard.

The success of the removable and interchangeable PCMCIA memory cards has led to the development of other types of peripheral devices that use the same standard. Of particular interest to the present application are the cards that contain radio transceivers and modems. These devices can be inserted into and connected to a receiving device in the same manner as a memory card. However, with these devices there is an additional connection which must be made to connect a radio antenna, a telephone line, a cellular phone, or an antenna for the cellular phone.

Radio frequency communication allows two or more computer terminals to communicate without actually being wired together. Many types of radio communication exist and many different radio frequencies and frequency ranges can and must be used to accommodate the different types of radio communication. For example, a radio that operates by sending the information on a single channel in the UHF band differs greatly from a radio that sends its information utilizing spread spectrum frequency hopping in the

1 2400-2483 MHz range. The antennas necessary to operate in the different frequency ranges
2 also differ. Similarly, modem communication, whether connected by traditional phone lines
3 or by cellular phones, allow computer devices that are not hardwired together to exchange
information.

4 Connection of the radio card or modem card to an outside antenna or telephone line
5 is typically made by either extending the length of the card beyond the standard card length
6 with the antenna or connection built into the extended portion or by having an antenna or
7 telephone cable protrude out of the end of the radio card to which the user may attach an
8 antenna or telephone line. These options have significant limitation. Both connections
9 severely limit the type of device that can accommodate the cards. Most devices cannot
10 accommodate the extra length without some modification and both connections make
11 environmentally sealing the connections difficult. Additionally, both connections are
susceptible to increased damage from dropping or other physical trauma. An external
antenna to which the user must couple an antenna is inconvenient and subjects the radio
periods of unreliability due to wear of the cable and connection.

12 An additional problem is converting computer devices that were not designed to
13 utilize radio or modem cards, and thus have no built in or attached antenna, into devices
14 that can utilize radio and modem cards while still avoiding the various antenna connection
problems discussed above.

15 Thus, there is a need in a computer terminal for an improved apparatus for
16 connecting a removable card type radio or modem to an antenna or telephone line attached
17 to or built within the computer terminal. Additionally, there is a need for an improved
18 computer device apparatus for connecting a removable card type radio to a protected,
interchangeable, environmentally sealed antenna.

19 Disclosure of the Invention

20 The present invention relates generally to computer devices utilizing removable radio
21 frequency communication devices used for transmitting and receiving information and more
22 particularly to an improved apparatus for connecting an appropriate antenna to the radio
23 frequency communication device using an antenna cap, and to an improved method and
24 apparatus for connecting a communication card device such as a radio or modem to an
appropriate antenna or telephone line.

25 In one embodiment, a removable radio card can be inserted into a receiving device
26 which is part of a computer terminal. The radio card has an electrical interface which
27 engages with an interface on the receiving device. The interface on the receiving device is
connected to the computer terminal and when the interfaces are engaged, communication

1 between the radio card and the computer terminal is possible. Additionally, the receiving
2 device is connected to at least one antenna by means of an antenna cable which has a pair
3 of contacts located on the receiving device. This pair of receiving device antenna contacts
4 encounter a pair of antenna contacts on the radio card. This connection allows the radio
5 card to utilize an antenna located on or within the receiving device. Additionally, the
6 connection of a modem card to a telephone, cellular phone, or antenna for a cellular phone
7 can be accomplished in substantially the same manner.

8 In another embodiment of the present invention a radio card or modem card which
9 is inserted into the computer terminal contains one set of contacts which encounter a
10 corresponding set of contacts located on the receiving device. The receiving device contacts
11 are connected to a switching matrix which is in turn connected to at least one of radio
12 frequency antennas, a cellular phone, an antenna for cellular phone, or a jack for connection
13 to a standard telephone line. As part of the regular communication with the radio card or
14 modem card the computer terminal interrogates the radio card or modem card and
15 determines to which antenna or telephone line the card should be connected.

16 In still another embodiment of the present invention the radio card antenna contacts
17 are at the opposite end of the radio card with respect to the electrical interface. In this
18 embodiment, the computer device includes a cap which engages with the opening in the
19 housing through which the radio card was inserted. The cap includes antenna contacts
20 positioned to engage the radio card antenna contacts. The cap is connected to one end of
21 a band. The other end of the band is connected to the housing of the computer device. An
22 antenna can be embedded in the cap, embedded in the band or embedded in or on the
23 housing of the computer device. Connection of the antenna contacts on the cap and of the
24 antenna is accomplished through the cap and utilizes either wire connections or a micro
25 shield ribbon.

26 Different radio cards may transmit on different frequencies and therefore need
27 different antennas. Multiple antennas allow the radio cards to selectively transmit and
28 receive on different antennas based upon the frequency used for communication.
Additionally, two similar antennas disposed in different positions can be used to implement
an antenna diversity scheme.

An object of the present invention is to provide an improved antenna connector for
use with radio cards which can be inserted into various computer devices.

Another object of the present invention is to provide an improved antenna connector
which is reliable, economical and easy to use.

A further object of the present invention is to provide an improved antenna

1 connector whereby an appropriate antenna will be connected to a radio card by selectively
2 positioning the antenna contacts on the radio card.

3 Another object of the present invention is to provide an improved antenna connector
4 whereby a radio card may simultaneously connect to and utilize more than one radio
5 antenna.

6 Still another object of the present invention is to provide an improved apparatus for
7 connecting a modem card to a telephone line, cellular telephone or antenna for a cellular
8 phone.

9 A further object of the present invention is to provide an improved apparatus which
10 utilizes only one set of contacts on the radio card or modem card and uses a switching
11 matrix to connect the radio card or modem card to the appropriate antenna or telephone
12 line.

13 Another object of the present invention is to provide an antenna cap for use with
14 computer devices utilizing radio cards.

15 Another object of the present invention is to provide an antenna cap which is
16 reliable, economical and easy to use.

17 A further object of the present invention is to provide an antenna cap whereby an
18 appropriate antenna will be connected to a radio card by selectively positioning the antenna
19 contacts on the radio card.

20 Another object of the present invention is to provide an antenna cap whereby a radio
21 card may simultaneously connect to and utilize more than one radio antenna.

22 Still another object of the present invention is to provide an antenna cap which
23 provides an antenna for computer devices which do not have a built in antenna.

24 Other objects, advantages, and novel features of the present invention will become
25 apparent from the following detailed description of the invention when considered in
26 conjunction with the accompanying drawings.

27 Brief Description of the Drawings

28 Fig. 1 is a perspective view of a radio card and a corresponding port for receiving the
radio card built in accordance with the present invention;

Fig. 2 is a partial top plan view of a radio card and port for receiving the radio card
with the radio card completely inserted in the port;

Fig. 3 is a partial side elevational view taken along line 3-3 showing the male/female
pin connection of the radio card and the port of Fig. 2;

Fig. 4 is a front view taken along line 4-4 showing the female pin connections of the
radio card of Fig. 1;

1 Fig. 5 is a perspective view of computer terminal showing the slot for receiving the
2 radio card;

3 Fig. 6 is front view taken along line 6-6 showing how a radio card to be inserted into
4 the slot of the computer terminal of Fig. 5;

5 Fig. 7 is a perspective view of another radio card and a corresponding port for
6 receiving the radio card built in accordance with the present invention;

7 Fig. 8 is a front view of another computer terminal and end cap capable of receiving
8 a radio card;

9 Fig. 9 is a top view taken along line 9-9 of the computer terminal of Fig. 8;

10 Fig. 10 is a bottom view taken along line 10-10 of the computer terminal of Fig. 8
11 with the end cap removed;

12 Fig. 11 is a side elevation view taken along line 11-11 of the computer terminal of
13 Fig. 8 with the slot for the radio card shown in dashed lines;

14 Fig. 12 is a partial top view taken along line 12-12 of the computer terminal of Fig.
15 11 showing the slot for receiving the radio card and the antennas;

16 Fig. 13 is a partial top view of yet another embodiment of a computer terminal built
17 in accordance with the present invention showing the use of a switching matrix;

18 Fig. 14 is a back view of a computer device and radio card built in accordance with
19 the present invention;

20 Fig. 15 is a side elevational view taken along line 15-15 of Fig. 14 of the computer
21 device and radio card;

22 Fig. 16 is a partial top view taken along line 16-16 of Fig. 14 of the computer device;

23 Fig. 17 is a partial side elevational view of another computer device built in
24 accordance with the present invention;

25 Fig. 18 is a top view taken along line 18-18 of Fig. 17 of the computer device showing
26 the rubber cap inserted therein;

27 Fig. 19 is a partial vertical sectional view taken along line 19-19 of Fig. 18 showing
28 a radio antenna embedded within the rubber cap;

Fig. 20 is a partial vertical section view taken along line 20-20 of Fig. 19 of the
rubber cap;

Fig. 21 is a partial vertical sectional view of another embodiment of the present
invention;

Fig. 22 is a partial vertical sectional view of still another embodiment of the present
invention;

Fig. 23 is a partial back view taken along line 23-23 of Fig. 15 of the computer

1 device;

2 Fig. 24 is a partial back view of still another embodiment built in accordance with
3 the present invention;

4 Fig. 25 is a partial horizontal sectional view taken along line 25-25 of Fig. 24 of the
5 band showing the shielded ribbon used to carry the antenna signals;

6 Fig. 26 is partial back view of a computer device of yet another embodiment of the
7 present invention;

8 Fig. 27 is a circuit diagram of a switching matrix for microprocessor control of
9 antenna selection; and

10 Fig. 28 is a circuit diagram showing an antenna diversity scheme which can be
11 incorporated into the switching matrix circuit of Fig. 27.

12 Best Modes for Carrying Out the Invention

13 Referring now to the drawings wherein like reference numerals designate identical
14 or corresponding parts throughout the several views, Fig. 1 shows a radio card (10) and a
15 receiving device (11) built in accordance with the present invention. The radio card (10)
16 has a housing (13) inside which is a completely operation radio transceiver (not shown).
17 The receiving device (11) in this embodiment of the present invention uses a pair of
18 opposed slots (14) to receive and guide the incoming radio card (10).

19 The radio card (10) has a pair of antenna contacts (15) positioned along the edge of
20 the housing (13). The receiving device (11) has a corresponding pair of antenna contacts
21 (16). As can be seen in Fig. 2, when the radio card (10) is fully inserted into the receiving
22 device (11) the antenna contacts (15) on the radio card housing (13) electrically encounter
23 the corresponding set of antenna contacts (16) positioned on the receiving device (11). The
24 antenna contacts (16) on the receiving device (11) are connected to an antenna cable (18).
25 The antenna cable (18) is in turn connected to an antenna (not shown). Thus, when the
26 radio card (10) is fully inserted into the receiving device (11) the radio card (10)
27 automatically is connected to an antenna.

28 Referring again to Fig. 1, a radio card (10) may have antenna contacts (20), shown
in dashed lines, located at different positions on the housing (13). Similarly, the receiving
device (11) may have several additional pairs of antenna contacts (22). The additional pairs
of antenna contacts (22) on the receiving device (13) can be used to allow access to several
different antennas depending on the type and frequency of radio communication to be
utilized by the radio card (10). This access is accomplished through additional antenna
cables (23) attached to the additional contacts (22). Thus, if the receiving device (13) is part
of a hand held computer terminal which has more than one antenna attached or built in,

1 different pairs of contacts (16 & 22) can be used to allow access by the radio card to the
2 different antennas depending upon the frequency and range characteristics of each antenna.
3 While a radio card (10) may only operate at one frequency and thereby only need one
4 antenna and therefore only have one pair of antenna contacts, the receiving device (11) still
5 may have several pairs of antenna contacts (16 & 22) all but one of which do not correspond
6 to any pair of radio card (10) antenna contacts (15).

7 Referring to Figs. 3 and 4, when the radio card (10) is inserted into the receiving
8 device (11) an interface between the radio card (10) and the receiving device (11) is
9 produced. The receiving device (11) has a plurality of pins (30) which form the male
10 portion of a connector. The radio card (10) has a corresponding plurality of holes (31)
11 which form the female portion of the connector and which engage the pins (30). The pins
12 (30) are connected to the computer terminal (not shown) by a series of electrical
13 connections (33) such as wires or electrical ribbon. The holes (31) in the radio card (10)
14 are electrically connected to the radio. When the pins (30) are engaged in the holes (31),
15 electrical signals can be exchanged between the radio card (10) and the computer terminal.
16 The electrical signals can be in the form of information exchange, power supply or both.

17 The radio card (10) of Figs. 1-4 might also be a modem card (not shown). In this
18 embodiment, the connections would be the same as previously described with the only
19 difference being that instead of the contacts connecting the modem card to a radio antenna,
20 the modem card would be connected to a traditional telephone line, a cellular phone or an
21 antenna for a cellular phone if the cellular phone was contained within the modem card.
22 Any necessary coupling transformer may be built within the computer terminal.

23 Referring to Figs. 5 and 6, a computer terminal (40) is shown built in accordance
24 with the present invention. The computer terminal (40) has a slot (42) for receiving a radio
25 card (44). The user of the computer terminal (40) lifts up a flexible cover (46) and inserts
26 the radio card (44) into the slot (42). The radio card (44) engages with the computer
27 terminal (40) in a similar manner as described in Figs. 1-4. The radio card (44) has a pair
28 of antenna contacts (48) which engage with a corresponding pair of contacts inside the
computer terminal (40). The pair of antenna contacts inside the computer terminal are
connected to a radio antenna (not shown).

Referring to Fig. 7, another embodiment of the present invention is shown. The
radio card (50) has two pairs of antenna contacts (52 & 53) which will encounter
respectively two pair of antenna contacts (55 & not shown) on the receiving device (58).
This embodiment accommodates a radio card (50) which can operate at two different
frequencies which require two different antennas. Standardization of antenna contact

1 position with antenna type is anticipated and covered by the present invention.

2 Referring to Figs. 8-12, another embodiment of a computer terminal (60) built in
3 accordance with the present invention is shown. The computer terminal (60) has a
4 removable end cap (62). When the end cap (62) is removed, a slot (60) is revealed which
5 is used to receive a radio card (66). The slot (64) in the computer terminal (60) has three
6 pairs of antenna contacts (67, 68 and 69) which are respectively connected to three different
7 radio antennas (71, 72 and 73). The radio card (66) in this embodiment only has one pair
8 of antenna contacts (75). Thus, when the radio card (66) is inserted into the slot (64), the
9 antenna contacts (75) will match up to the antenna contacts (67) and the radio will utilize
10 the internal antenna (71). The external antenna (73) and the other internal antenna (72)
11 will not be used by this particular radio card (66).

12 Referring now to Fig. 13, still another embodiment of a computer terminal (80) built
13 in accordance with the present invention is shown. A communication card (85) is inserted
14 into the computer terminal (80). The card (85) can either be a radio card or a modem card.
15 The card (85) has a set or pair of contacts (87) which encounter a set or pair of contacts
16 (88) disposed on the receiving portion of the computer terminal (80). The contacts (88) are
17 electrically connected to a switching matrix (90), thus the radio card or modem card (85)
18 is electrically connected to the switching matrix (90).

19 The switching matrix (90) is connected to a plurality of antennas (92, 93 and 94) and
20 to a telephone jack (95). The switching matrix (90) is used to electrically and selectively
21 connect the radio or modem card (85) to the appropriate antenna or to a telephone line.
22 The switching matrix (90) is controlled by the control microprocessor (98) of the computer
23 terminal (80). The control microprocessor interrogates the card (85) to determine what kind
24 of card it is and to determine what antenna or telephone connection it needs. The control
25 microprocessor then signals the switching matrix (90) which connects the card (85) to the
26 appropriate antenna (92, 93 or 94) or to the phone jack (95).

27 It should be noted that the design of a switching matrix which is to accommodate
28 both RF and telephone connections must take into account the different voltage
requirements for each type of communication. For example, the Sony CXG1002 switch
discussed below cannot handle the range of voltages necessary for compliance with
telephone standards.

Referring now to Fig. 27, a circuit diagram (280) for antenna switching matrix is
shown. The circuit (280) allows a radio card to be connected to one of two or more internal
or connected antennas of a portable computer device. The circuit shown allows antennas
(305 and 306) for one of two frequency bands to be selected. The design can be extended

1 to allow additional bands to be added by appropriate selection of a switching device.

2 The illustrated circuit is based upon a Sony CXG1002 GaAs JFET switch (282).
3 Switching is initiated by the control microprocessor (284) within the computer device. This
4 microprocessor (284) may be a dedicated communications or control microprocessor, or it
5 may be the main processor that runs local applications.

6 Upon initial power up of the computer device, the control microprocessor (284)
7 interrogates the radio card via the bus interface (286) to ascertain its type and frequency
8 band of operation. PCMCIA standards include provisions for device identification. Based
9 upon the result of the interrogation, the microprocessor (284) selects the appropriate logic
10 levels from a logic level table (290) for application to the Control A line (292) and Control
11 B line (294) to the CXG1002 switch (282) in order to select the proper antenna for the
12 radio card. For example, if the computer device is designed to accommodate 900 MHz
13 paging receivers and 2.4 GHz wireless local area network transceivers, antenna A (288)
14 would be a 900 MHz antenna and antenna B (289) would be a 2.4 GHz antenna.

15 An optional diversity sense circuit is also shown. This circuit allows the radio card
16 to provide a diversity select signal through the RF connector. The coil (298) is an RF
17 choke, allowing low frequency signals to pass, but blocking RF signals.

18 Referring now to Fig. 28, a second circuit (300) illustrating how the diversity select
19 circuit is implemented is shown. The B antenna output (301) from the band selector is
20 applied to a second CXG1002 switch (320). Two antennas (305 and 306) appropriate for
21 2.4 GHz are designed into the computer device. These antennas (305 and 306) provide
22 either spatial or polarization diversity, or a combination of the two.

23 Selection of the antenna used is controlled by the radio card. The diversity sense line
24 (308) is used to control the CXG1002 switch (302). The inverter (310) provides buffering
25 and allow a single signal output from the radio card to be used for antenna selection.
26 Alternatively, the diversity sense could be provided to the control microprocessor which
27 could then in turn control the selection of antennas.

28 Selection diversity could be employed in both the A and B antenna paths if desired
with the addition of a CXG1002 switch in the A path. This switch could be controlled by
the same circuitry as the B switch, eliminating the need for separate control circuitry for the
A path.

Referring again to Fig. 13, in another embodiment, the control microprocessor (92)
is located within the radio card (85). In this configuration, the control microprocessor (92)
selects the appropriate antenna by controlling the switching matrix (90) via the antenna
interface (88). Thus, the control microprocessor (92) either has preset knowledge of the

1 switching matrix and antenna availability, or may interrogate the microprocessor within the
2 receiving unit for such detail.

3 In addition, in alternate embodiments, the radio card itself contains an antenna (not
4 shown). In most configurations of this embodiment, if no alternate antenna is found within
5 the receiving device, the radio card uses its own antenna. In such configurations, the radio
6 card uses its own antenna as a backup, preferring to use of the receiving device's antennas
7 if available. In other configurations, the radio card may choose the most effective antenna,
8 which may either be its own or the receiving device's antenna. Such a choice may either be
9 predetermined or made based on actual use, i.e., based on received signal strength
10 indications (RSSI) or other signal or communication quality assessments. For example,
11 referring to Fig. 12, a local antenna is housed within the radio card (64). Thus, if the radio
12 card (64) cannot detect receiving device antennas, the radio card (64) chooses its own locally
13 contained antenna. Referring to Fig. 13, in another exemplary configuration, the radio card
14 (85) also contains its own internal antenna. The control microprocessor (92) not only
15 chooses from among antennas stored within the receiving device, but also considers the
16 antenna stored in the radio card (85). Note that, in addition to any antennas placed in the
17 receiving device, the radio card might also be configured with a plurality of antennas.

18 Referring now to Figs. 14, 15 and 16, a computer device (111) for utilizing a radio
19 card (110) built in accordance with the present invention is shown. The computer device
20 (111) has a housing (112). Inside the radio card (110) is a completely operation radio
21 transceiver (not shown). The computer device (111) has an opening (114) in the housing
22 (112) through which the radio card (110) can be inserted into the computer device (112).
23 In the present embodiment of the invention, the receiving means for the computer device
24 is a slot (115).

25 When the radio card (110) is inserted into the slot (115) in the computer device (111)
26 an interface between the radio card (110) and the computer device (111) is produced. The
27 computer device (111) has a plurality of pins (not shown) which form the plug or male
28 portion of a connector. The radio card (110) has a corresponding plurality of sockets or
holes (not shown) which form the receptacle or female portion of the connector and which
engage the pins. The pins are connected internally and electrically to the computer device
(111) by a series of electrical connections such as wires, printed circuit traces or electrical
ribbon. The holes in the radio card (110) are electrically connected to the radio transceiver.
When the pins engage the holes, electrical signals can be exchanged between the radio
transceiver inside the radio card (110) and the computer device (111). The electrical signals
can be in the form of information exchange, power supply or both. The radio card (110)

1 includes antenna contacts (117) to engage corresponding radio antenna contacts that are
2 connected to an appropriate antenna.

3 The computer device (111) includes a cap (120) which is designed to matingly engage
4 the opening (115) in the housing (112) of the computer device (111) and thereby cover the
5 slot (115) used to receive the radio card (110). A flexible band (122) attaches the cap (122)
6 to the housing (112) of the computer device (111). One end of the band (122) is connected
7 to the cap (122) while the other end is attached to the housing (112). A handle (124) helps
8 assist the removal of the cap (120) from the housing (112) of the computer device (111).

9 The cap (120) is constructed of a closed cell foam material with high air content for
10 low dielectric losses. Alternatively, a quality dielectric material may be used to reduce the
11 size of the antenna structure. The cap (120) when made of a foam material helps to protect
12 the radio card from the physical trauma typically associated with computer devices of these
13 types. Additionally, as will be discussed in further detail below, the cap (120) helps to
14 environmentally seal the opening (114) preventing harmful material from the outside such
15 as dust or moisture from reaching the radio card (110) and helps to reduce the escape of
16 electronic noise from the housing (112) created by the radio card (110) and computer device
17 (111). As will be discussed below, a grounded metal shield covering a portion of the cap
18 (120) is used to reduce the escape of electronic noise.

19 While the cap (120) helps to seal the opening, protect the radio card (110) and hold
20 the radio card in place, the primary function of the cap is to provide the radio card (110)
21 access to an appropriate antenna or antennas. The connection of the radio card (110) to
22 the antenna is made through the cap (120). The antenna or antennas can be embedded in
23 the cap (120), embedded in the band (122) or even attached to, mounted on, or embedded
24 in the housing (112) of the computer device (111).

25 Referring now to Figs. 17 and 18, a computer device (130) built in accordance with
26 the present invention is shown with a cap (134) engaged in the opening of the housing (132)
27 wherein a radio card can be inserted. A band (136) is attached to both the cap (134) and
28 the housing (132). The band (136) helps prevent the loss of the cap (134) when the cap
(134) is not engaged in the housing (132) of the computer device (130).

Referring now to Figs. 19 and 20, the cap (132) is shown engaged with the housing
(132) of the computer device (130). The cap (134) includes an outwardly extending lip (136)
which helps to environmentally seal the opening in the housing (132) preventing harmful
material from the outside such as dust or moisture from reaching the radio card (140) which
has been inserted into the computer device (130). When the cap (134) is completely
inserted or fully engaged in the housing (132), the lip (135) sealingly engages the housing

1 (132).

2 Embedded in the cap (134) is an antenna (150). The antenna (150) is connected to
3 the radio card (140) through contacts (151 and 152) disposed on the cap (134) and contacts
4 (141 and 142) disposed on the radio card (140). Contact (152) is the ground contact for the
5 antenna (150) and is connected to the end of the antenna (150). Contact (142) is the
6 ground contact for the radio card (140). Contact (151) is the signal contact and is connected
7 to the antenna (150) a short distance from the end of the antenna (150). Contact (141) is
8 the signal contact for the radio card (140).

9 Contact (151) and contact (141) are disposed on the cap (134) and the radio card
10 (140), respectively, such that the contacts engage each other when the cap (134) is inserted
11 into or engaged with the housing (132) of the computer device (130). Similarly, contact
12 (152) and contact (142) are disposed on the cap (134) and the radio card (140), respectively,
13 such that the contacts engage each other when the cap (134) is inserted into or engaged with
14 the housing (132) of the computer device (130). The contacts shown in the present
15 embodiment are of the metal button type wherein the connection is made when the two
16 metal surfaces meet. Many variations of the contacts are possible including the use of
17 male/female connections and spring type contacts.

18 A shield (148) is disposed around the bottom portion of the cap (134) and is used
19 to reduce the escape of electronic noise. Typically in computer devices of this type, the
20 inside of the housing of the computer device is shielded. Additionally, the area immediately
21 surrounding the radio device such as a radio card may also be shielded. By shielding the
22 cap (134), the integrity of the housing and radio shields are not breached by the opening
23 used to insert and remove the radio card. The shield (148) is connected to the antenna
24 ground contact (152) on the cap (134). A hole (159) in the shield (148) allows the signal
25 contacts (151 and 141) to engage without being grounded.

26 Referring now to Fig. 21, the cap (134) is shown embedded within which are two
27 antennas (160 and 162) designed to receive and transmit different radio frequency signals.
28 The first antenna (160) and the second antenna (162) are both connected to a common
ground contact (167) which is connected to the shield and which engages the ground contact
(177) on the radio card (170). The first antenna (160) is connected to a first signal contact
(165) and is disposed on the cap (134) to engage a first signal contact (175) disposed on the
radio card (170). Similarly, the second antenna (162) is connected to a second signal
contact (166) and is disposed on the cap (134) to engage a second signal contact (176)
disposed on the radio card (170). Thus the radio card (170) will use a signal via contact
(175) or via contact (176) depending upon which antenna it would like to use. Which

1 antenna it would like to use is dependent upon the desired frequency upon which it want
2 to transmit and receive.

3 The radio card (170) as shown has three contacts (175, 176 and 177). However, if
4 the radio transceiver in the radio card (170) is designed such that it would only be able to
5 transmit and receive signals which correspond to the first antenna (160), then it would not
6 need to have contact (176) and it could be left off. Similarly, if the radio card (170) were
7 only going to use second antenna (162) then contact (175) could be omitted. Thus,
8 standardizing contact position with respect to antenna type allows for flexibility in cap usage
9 with various radio cards such that only appropriate antennas will be connected to the radio
10 card.

11 Referring to Fig. 22, two antennas (180 and 182) are embedded in the cap (134). In
12 this embodiment built in accordance with the present invention, the two antennas (180 and
13 182) not only share a common ground contact (186) which engages the ground contact (196)
14 of the radio card (190), but they also share a common signal contact (185) which engages
15 the signal contact (195) on the radio card (190). Thus, both antennas receive and transmit
16 signals using the same two contacts. This embodiment requires a radio card (190) which
17 can filter the different signals and thus use the signal from the desired antenna while
18 ignoring the signals which arrive via the other antenna.

19 Referring to Fig. 23, a computer device (111) built in accordance with the present
20 invention is shown which is designed to implement an antenna diversity scheme. A first
21 antenna (201) is embedded in the cap (120). A second antenna (202) is shown embedded
22 in the band (122). As discussed in the embodiment as shown in Fig. 21, the two antennas
23 (201 and 202) share a common ground contact (207). The first antenna (201) is connected
24 to a signal contact (205). Likewise, the second antenna (202) is connected to a signal
25 contact (206). The hole (149) in the shield (148) which prevent the signal contacts (205 and
26 206) from grounding is shown in dashed lines.

27 The first antenna (201) is similar to the second antenna (202) and both are designed
28 to transmit and receive similar radio frequency signals. When the cap (120) is engaged in
the opening of the housing (112), the first antenna (201) and the second antenna (202) will
be perpendicular with respect to each other. The quality of the signal received by the first
antenna (201) and the quality of the signal received by the second antenna (202) may be
greatly different since the antennas are place at right angles with respect to each other. In
the present embodiment, the radio card can check the quality of each signal and use the
antenna which is currently receiving the stronger signal. Additionally, it can switch to the
other antenna when the conditions change such that the signal is no longer acceptable.

1 Utilizing two similar antennas in this matter, antenna diversification, can be very important
2 in computer terminals of this type since they are often mobile and are often subjected to a
3 rapidly changing environment. An antenna diversification scheme of this type can be used
4 to help eliminate the reception problems associated with signal multipath.

5 Referring now to Fig. 24, another embodiment of the present invention is shown with
6 the first antenna (211) and the second antenna (212) attached to the housing (112) of the
7 computer terminal (111). As in the embodiment shown in Fig. 23, the first antenna (211)
8 is similar to the second antenna (212) and both are designed to transmit and receive similar
9 radio frequency signals and are perpendicular with respect to each other such that an
10 antenna diversity scheme can be implemented. The antennas (211 and 212) are connected
11 to the contacts (205, 206 and 207) through the cap (120) and through the band (112).

12 Referring to Fig. 26, the embodiment of Fig. 24 is shown with the only differences
13 being that the first antenna (221) and the second antenna (222) are positioned slightly
14 differently and the antennas are designed to transmit and receive different radio frequency
15 signals. Thus, the radio card uses the signal on contact (205) when it wants to receive
16 signals via the first antenna (221) and uses the signal on contact (206) when it wants to
17 receive signal via the second antenna (222).

18 In Figs. 23, 24 and 26, the portion of the connection between the contacts (205, 206
19 and 207) and the antennas which pass through the band (112) are shown schematically as
20 wires. In the best mode of the present invention, the transmission of the signal through the
21 band (112) would be accomplished through the use of a micro shield strip (230) as shown
22 in Fig. 25. The micro shield strip consists of several conductive ribbons running the length
23 of the band (112) and separated by the non-conductive material of the band (112). A wide
24 top ribbon (233) and a wide bottom ribbon (234) are used to sandwich two smaller ribbons
25 (236 and 237). The smaller ribbons (236 and 237) are used to transmit the antenna signals
26 and are connected to contacts (205 and 206) respectively. The wide bands (233 and 234)
27 are common to each other and are used to ground each of the antennas and are connected
28 to the ground contact (207) on the cap (120). The wide ground ribbons (233 and 234) shield
the smaller antenna signal ribbons (236 and 237) and help to maintain the signal integrity.
The impedance of the micro-shield strip is determined by relative spacing and dimensions
of the strip as well as the dielectric constant of the material of the band.

Obviously, many modifications and variations of the present invention are possible
in light of the above teachings. It is therefore to be understood that, within the scope of the
appended claims, the invention may be practiced otherwise than as specifically described.